POPULATION CHARACTERISTICS OF HUMPBACK WHALES IN GLACIER BAY AND ADJACENT WATERS: 1999

by

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ABSTRACT

We photographically identified 104 individual humpback whales (*Megaptera novaeangliae*), including 9 mother/calf pairs, in Glacier Bay and Icy Strait between June 1 and August 31, 1999. This is the highest number of whales documented in the study area since the monitoring program began in 1985 and it contributes to an increasing trend from 1985 to 1999. An additional mother/calf pair was identified in May, outside of the normal survey period. Twenty-eight whales were resident in Glacier Bay and 26 were resident in Icy Strait for more than 20 days. Four whales that had not been sighted in the study area since they were calves were identified, bringing the 1974-1999 total number of returning offspring to 31. Twelve of the 23 known-age whales in the study area in 1999 were born to just 4 females (#236, #530, #581, #801). Sea surface temperatures were lower in 1999 than in 1998 when the *El Nino* Southern Oscillation caused a general warming of ocean temperatures. Analysis of a scat sample from a calf in Glacier Bay contained the remains of fish (tentatively identified as juvenile walleye pollock (*Theragra chalcogramma*) and Pacific herring (*Clupea harengus pallasi*)) and invertebrates (possibly euphausiids and Crangonid shrimp). Numerous whale/vessel interactions, including two collisions, occurred in and near the study area.

INTRODUCTION

This report summarizes the findings of the National Park Service's (NPS) annual humpback whale monitoring program during the summer of 1999, the fifteenth consecutive year of consistent data collection in Glacier Bay National Park and adjacent waters in Icy Strait. The initial impetus for this program stemmed from concern in the late 1970’s that an increase in vessel traffic in Glacier Bay National Park (GBNP) may have caused a large proportion of the local whale population to abandon the bay (Jurasz and Palmer 1981a). Humpback whales are federally listed as an endangered species; the federal government is mandated to ensure that federal actions (including park management decisions) do not negatively impact endangered species.

In the early 1980's, research on whale prey distribution, underwater sound and whale behavior in the presence of vessels investigated whether changes in whale distribution were linked to vessel presence and/or natural variability in prey distribution. Researchers found that humpback whales change their behavior in the presence of vessels (Baker et al. 1982; Baker et al. 1983; Baker and Herman 1989) and that there is substantial spatial and temporal variability in whale prey distribution which may be responsible for changes in whale distribution (Wing and Krieger 1983; Krieger and Wing 1984, 1986). Researchers also documented underwater sound generated by various types of vessels operating at a range of speeds (Malme et al. 1982; Miles and Malme 1983). The NPS concluded that any of these factors alone, or in combination, could influence whale distribution. In 1999, GBNP, the U.S. Navy and five cruise ship companies began a collaborative study to quantify the underwater sound produced by cruise ships and other vessels that visit Glacier Bay. These data will be used to help further evaluate the potential for minimizing the effects of vessel noise on whales and other marine life in GBNP.

The current study began in 1985 when the NPS initiated an annual monitoring program to systematically characterize the humpback whale population in Glacier Bay and Icy Strait. The study area spans both Glacier Bay and Icy Strait because whales frequently move between these areas within and between years, effectively making them a single contiguous habitat. Each summer, GBNP biologists document the number of individual whales, as well as their residence times, spatial and temporal distribution, reproductive parameters and feeding behavior. These data are used to monitor long-term trends in the population's abundance, distribution, and reproductive rates. Since 1993, biologists have recorded the water depth and temperature in areas used by humpback whales to characterize the abiotic features of their feeding habitat. In addition, human-whale interactions including strandings, entanglements in fishing gear and disturbance by vessels and aircraft are documented opportunistically. Photographic identification data are shared with other researchers studying North Pacific humpback whales through a central data repository, the National Marine Mammal Laboratory in Seattle, Washington. In addition, whale distribution data are used locally by Park biologists to determine when and where special NPS vessel course and speed restrictions ("whale waters”) should be implemented each summer in Glacier Bay.

The whales that use Glacier Bay and Icy Strait are part of the southeastern Alaska feeding herd, estimated at 404 whales (95% confidence limits 350 to 458) between 1979 and 1992 (Straley 1994). The number of whales documented in Glacier Bay and Icy Strait from 1985 to 1998 ranged from 41 to 92 (Gabriele and Doherty 1998). In 1998, a statistically significant increasing trend in the whale counts in Glacier Bay was documented for the first time since the study began in 1985. Prior to 1998, Icy Strait and the combined area had shown an increasing trend since 1996 (Gabriele et al. 1997). Throughout the study, site fidelity to the study area has been high, with the majority of whales (70%) identified in two or more years (Gabriele 1997). Whale movement throughout southeastern Alaska is presumed to be linked with prey availability and likely influences the number of whales in the study area (Baker et al. 1990; Krieger 1990; Straley and Gabriele 1995; Straley 1994).

Whales in the study area typically feed alone or in pairs, primarily on small schooling fishes such as capelin (*Mallotus villosus*), juvenile walleye pollock (*Theragra chalcogramma*), sand lance (*Ammodytes hexapterus*) and Pacific herring (*Clupea harengus pallasi*) (Wing and Krieger 1983; Krieger and Wing 1984, 1986). Most whales in the study area feed alone, with the exception of a large, stable "core group" that is commonly found at Point Adolphus, and the less consistent occurrence of large pods at Bartlett Cove and Pleasant Island Reef (Baker 1985; Perry et al. 1985; Gabriele 1997). Bubblenet, lunge and flick feeding generally occur infrequently compared with subsurface feeding (Jurasz and Jurasz 1979; Wing and Krieger 1983; Krieger and Wing 1984, 1986; Gabriele et al. 1997). In 1998, an unusually high number of incidences of bubblenet feeding were observed in upper Glacier Bay (Gabriele and Doherty 1998). This year's monitoring efforts add the fifteenth year of data to an increasingly valuable time series on humpback whale natural history and allow us to examine the continuity of the species' presence and behavior in the study area over time.

METHODS

The methods for this project have been described in previous reports. The primary techniques have not changed significantly since 1985, allowing for valid comparison of data between years. The specific methods used in 1999 are outlined below.

Vessel Surveys: We conducted surveys in Glacier Bay and Icy Strait from May 14 through September 29, 1999. We searched for, observed and photographed humpback whales from a 6 m Boston Whaler powered with a 60 hp outboard engine. To minimize the potential impact that monitoring efforts might have on whales, we typically did not conduct surveys in the same area on consecutive days. However, if circumstances such as time, weather, or the presence of other vessels interfered with obtaining whale identification photographs, we occasionally returned to the same area the following day.

We surveyed the main body of Glacier Bay (a rectangle defined by four corners: Bartlett Cove, Point Carolus, Geikie Inlet and Garforth Island) 3 to 4 days per week (Fig. 1). We surveyed the West Arm of

Glacier Bay (as far north as Russell Island) approximately bi-weekly. We surveyed the East Arm of Glacier Bay (as far north as Adams Inlet) when other vessels reported whale sightings in that area. We performed approximately one Icy Strait survey per week, with the greatest survey effort along the shoreline of Chichagof Island from Pinta Cove to Mud Bay (Fig. 1). Several surveys included Lemesurier Island and twice we surveyed the mouth of Idaho Inlet.

After we found whales, we recorded the latitude and longitude coordinates of their initial location, determined with either a Rockwell PLGR (using NAD27-Alaska datum), Trimble Pathfinder (using Alaska/Canada datum) or Garmin III Plus (using NAD27-Alaska datum) Global Positioning System (GPS). We defined a pod of whales as 1 or more whales within 5 body lengths of each other, surfacing and diving in unison. We used datasheets to record all information pertaining to the pod, including the number of whales, their activity (feed, travel, surface active, rest, sleep, unknown), sketches of the markings on their tail flukes and dorsal fin, photographs taken, whale identity (if known), water depth, temperature and any prey patches observed on the echo-sounder, as well as details pertaining to feeding behavior. We opportunistically monitored and recorded underwater sounds with a hydrophone and digital audio tape recorder.

Individual Identification: Each whale's flukes have a distinct, stable black and white pigment pattern that allows individual identification (Jurasz and Palmer 1981a; Katona et al. 1979). We took whale fluke photographs with a Nikon N90S camera equipped with a motor drive, databack and 300 mm lens (Fig. 2). We photographed the ventral surface of the flukes of each whale with 1600 ASA black and white film. Photographs of the dorsal fin, which also allow for individual identification based on shape and scarification, supplemented the identification of individuals. Panda Lab in Seattle, Washington processed and printed the film. We analyzed the contact sheets and field notes to determine the date and location where each whale was photographed.

We compared photographs of individuals to previous NPS photographs and to other available catalogs (Cartwright unpublished data; Darling 1991; Jurasz and Palmer 1981a; Perry et al. 1985; National Marine Mammal Laboratory unpublished data; Perry et al. 1988; Sharpe unpublished data; Straley and Gabriele 1997; Uchida and Higashi 1995; von Ziegesar 1992) to determine the identity and past sighting history of each whale. We referred to many whales by an identification number issued by the Kewalo Basin Marine Mammal Laboratory (KBMML) catalog of North Pacific humpback whales (Perry et al. 1988).

Figure 2. Sample whale fluke identification photograph

Identification numbers lower than #950 coincide with those in the KBMML catalog; those higher than #950 are unique to the combined catalogs of Glacier Bay National Park and University of Alaska Southeast researcher Jan Straley (Straley and Gabriele 1997). We also referred to those whales first photo-identified by Jurasz and Palmer (1981a) by their nicknames (Appendix 1).

We assigned temporary identification codes to whales that had not been previously identified in Glacier Bay and Icy Strait, denoting the film roll and frame number of the identification photograph, for example GB99-12(4). We replaced temporary “filmcodes” with permanent identification numbers if we identified the whale on more than one day, or if it had been identified elsewhere or in previous years. We assigned calves an identification number if we obtained adequate photographs of the flukes, regardless of whether the calf was sighted on more than one day. We are able to identify an increasing number of whales by their dorsal fin alone, enabling us to augment the sighting histories of individuals whose dorsal fins we recognize from other observations accompanied by a fluke photograph. After we completed the photographic analysis, we added each whale's identity and the sighting data from the field notes to a Microsoft Access database containing Glacier Bay and Icy Strait whale sighting histories from 1977 to 1999. Finally, we printed and catalogued the best 1999 photograph of each individual.

Whale Counts: After we analyzed all of the photographs, we counted the number of distinct individual whales in the sample. We made separate counts of Glacier Bay and Icy Strait for the total monitoring period from 1 June to 31 August and for a 'standardized period' (after Perry et al. 1985) from 9 July to 16 August. Although the standardized period is substantially shorter than the current NPS June through August monitoring season, and the beginning and ending dates have no particular biological significance, continued use of the standardized period is currently the only way of comparing whale counts in 1982-1984 to subsequent years (Gabriele et al. 1995). We also determined the number of whales that were ‘resident’ in Glacier Bay, Icy Strait and the combined area. We defined a whale as resident if it was photographically identified in the study area over a span of 20 or more days (after Baker 1986).

Habitat Characteristics: At the start of each pod observation we measured sea surface temperature and water depth with a Raytheon V850 dual-frequency color video echo-sounder. We calibrated the temperature sensor with a scientific thermometer and found that the echo-sounder sensor was accurate to within 1.3 ^{o}C. The majority of the time the temperature from the echo-sounder was higher than the temperature from the scientific thermometer. We rounded depth measurements to the nearest meter.

Prey Assessment: We described the depth, density and morphology of prey patches appearing on the echo-sounder screen in the presence of whales. We used a standardized chart-speed setting (speed = 9) on the echo-sounder to ensure that images observed on different sampling occasions would be comparable. We intended to use standardized gain settings (gain = 75%) for the 50 kHz and 200 kHz transducers on the echo-sounder, but discovered at the end of the 1999 study period that the gains were set at unequal levels. Therefore, data on the comparative density of prey patches (indicated by the color of the patch on the 50 kHz vs. 200 kHz display) cannot be analyzed quantitatively. We recorded the water depth at the top and bottom of prey patches to the nearest meter. These data may also have been affected by the non-standardized gain settings and cannot be analyzed quantitatively. We qualitatively described prey patches using the following five categories: ‘*scattered*’- appeared like falling snow; a ‘*layer*’- a horizontal linear aggregation; a ‘*patch*’ - a non-discrete, shapeless aggregation; a ‘*ball*’ - a discrete, curvilinear form; and a ‘*mass*’ - completely filled the echo-sounder screen, such that we could not determine the shape of the aggregation. We used field guides (Hart 1988; Pearse et al. 1987; Smith and Johnson 1977) to taxonomically identify sample prey items that we opportunistically collected at the surface with a dip net. We opportunistically collected a sample of whale scat off the water’s surface using a dip net and sent the sample to Pacific Identifications, a professional laboratory specializing in fecal sample analysis, for identification of the prey remnants (Crockford 1998).

Statistical Analysis: Because our data may violate the assumptions of parametric statistics (Zar 1984), we used the nonparametric Mann-Whitney U and Kruskal Wallis to test differences between means. We used an alpha level of $p < .05$ to assess statistical significance.

RESULTS

Vessel Surveys: In Glacier Bay, the total number of survey days (n = 52) and hours (n = 318) during the 1 June – 31 August study period was slightly lower than in 1997 and 1998, but still higher than the 1985-1998 average of 41 survey days and 237 hours (Table 1, 2). We calculated the overall average duration of surveys for each year (Table 2), but this average may be misleading because there is a high level of variance in the length of individual surveys. However, we believe that this statistic is useful in comparing relative changes in the average number of hours per survey over the years.

Table 1. Humpback whale survey days per month in Glacier Bay and Icy Strait, 1985-1999.

	GLACIER BAY						ICY STRAIT					
Year	**May**	**June**	**July**	**Aug**	**Sept**	***TOTAL June-Aug***	**May**	**June**	**July**	**Aug**	**Sept**	***TOTAL June-Aug***
1985	0	10	11	10	0	*31*	0	7	4	3	1	*14*
1986	0	13	17	6	0	*36*	0	5	3	6	2	*14*
1987	3	12	12	5	1	*29*	2	5	7	7	2	*19*
1988	0	11	12	12	7	*35*	0	5	7	5	3	*17*
1989	3	17	14	16	1	*47*	1	6	6	7	4	*19*
1990	6	16	18	14	0	*48*	4	5	6	8	0	*19*
1991	7	14	17	13	6	*44*	3	7	6	4	3	*17*
1992	3	19	17	12	7	*48*	2	4	5	4	1	*13*
1993	2	10	13	7	1	*30*	1	3	3	5	1	*11*
1994	1	9	10	13	1	*32*	0	5	4	8	1	*17*
1995	3	10	11	10	2	*31*	2	4	4	7	2	*15*
1996	4	11	17	16	3	*44*	2	5	10	3	1	*18*
1997	5	17	21	19	9	*57*	2	4	7	6	4	*17*
1998	10	20	23	12	5	*55*	4	3	6	4	2	*13*
1999	4	16	18	18	5	*52*	1	4	6	3	1	*13*

Note: This table shows the number of survey days for May through September although our annual whale counts encompass June through August only.

In Glacier Bay, the average duration and temporal distribution of surveys during the 1999 study period were comparable to past years. In Icy Strait, the total number of survey days (n = 13) and hours (n = 64) during the study period were identical to the number of survey days in 1998, but lower than the 1985-1998 average of 16 days and 94 hours. The average duration of each Icy Strait survey was one hour shorter than the average duration of each survey in this region from 1985 to 1998 (4.9 hours vs. 5.9 hours). Survey effort in western Icy Strait was comparable to previous years (except 1998 when effort in this area was unusually low), but the number of surveys in eastern Icy Strait (n = 2) was lower than in previous years. Effort during May and September in both Glacier Bay and Icy Strait was lower than in recent years. However, data collected during these months are provided for descriptive purposes only and are not included in the analyses in this report.

Table 2. Survey hours in Glacier Bay and Icy Strait, June - August 1985-1999.

	GLACIER BAY			ICY STRAIT			
Year	survey hours	survey days	duration of average survey (hrs)	survey hours	survey days	duration of average survey (hrs)	*TOTAL hours*
1985	234	31	7.5	92	14	6.6	326
1986	-	-	-	-	-	-	-
1987	-	-	-	-	-	-	-
1988	199	35	5.7	108	17	6.4	307
1989	231	47	4.9	123	19	6.5	354
1990	215	48	4.5	115	19	6.1	330
1991	256	44	5.8	100	17	5.9	356
1992	248	48	5.2	71	13	5.5	319
1993	192	30	6.4	62	11	5.6	254
1994	169	32	5.3	92	17	5.4	261
1995	167	31	5.4	90	15	6.0	258
1996	259	44	5.9	116	18	6.4	374
1997	327	57	5.7	90	17	5.3	417
1998	344	55	6.3	64	13	4.9	397
1999	318	52	6.1	64	13	4.9	382

Note: Hours of effort for 1986 and 1987 are not available. Duration of average survey is calculated by dividing the number of survey hours by the number of survey days from June 1-August 31.

Whale Counts: One hundred and four individual humpback whales were photographically identified in Glacier Bay and Icy Strait between June 1 and August 31 (Table 3), exceeding the previous high count of 92 whales identified in 1998 and contributing to an increasing trend in the number of whales in the study area. We identified a record number of whales in Icy Strait between June 1 and August 31 (n = 66). The number of whales documented in Glacier Bay during the same time period (n = 60) is slightly lower than the number documented in Glacier Bay in 1998 (n = 62), but still far greater than the 1985-1998 average of 33 whales. The number of whales documented in Glacier Bay during the standardized period, July 9 to August 16, (n = 36) is slightly lower than in 1997 or 1998 but is greater than the 1985-1998 average of 24

Table 3. Counts of humpback whales in Glacier Bay and Icy Strait, 1982-1999.

Year	Glacier Bay		Icy Strait		Glacier Bay & Icy Strait	
	Standardized Count	Total Count	Standardized Count	Total Count	Standardized Count	Total Count
1985	7	15	19	30	24	41
1986	26	32	24	33	39	49
1987	18	29	33	48	40	60
1988	17	38	29	36	40	53
1989	20	24	20	28	32	41
1990	16	26	24	33	32	49
1991	17	19	33	42	44	53
1992	27	34	38	52	48	65
1993	24	31	24	30	40	50
1994	17	30	29	42	44	60
1995	18	28	26	44	37	57
1996	37	44	43	59	65	77
1997	41	55	33	50	66	82
1998	45	62	28	51	69	92
1999	36	60	40	66	69	104

Note: Total counts refer to the number of whales (adults and calves) identified during the entire monitoring season (1 June – 31 August). Standardized counts refer to the number of whales sighted between 9 July and 16 August each year. The combined count for Glacier Bay and Icy Strait is typically smaller than the sum of Glacier Bay and Icy Strait counts because some whales are identified in both areas.

whales. The number of whales documented in Icy Strait during the standardized period (n = 40) is higher than in recent years and greater than the 1985-1998 average of 29 whales. The 1999 standardized count for the combined Glacier Bay/Icy Strait area was high (n = 69) and further supports an increasing trend in whale counts in the study area.

We re-examined (Gabriele and Doherty 1998) the possibility that the increasing trend in whale numbers may be an artifact of an increase in photo identifications based solely on dorsal fin photos. From 1994 to 1999 (the only years for which comparable data were available), an average of 21.6% (s.d. = 3.5%) of all photo identifications were based on dorsal fin photos, the remainder being based on fluke photos (Table 4). In 1999, 23.6% of all photo identifications were based on dorsal fin photos. The total number of whales identified each year based solely on dorsal fin photos ranged from 1 to 3. No increasing trends are apparent in these data and the use of dorsal fin photos for identification does not appear responsible for the observed increase in whale numbers in recent years.

Table 4. Trends in dorsal fin photo identifications, 1994-1999.

Year	**Proportion of total identifications determined from dorsal fin photos**	**# of whales identified solely from dorsal fin photos***
1994	22.7%	3
1995	25.0%	2
1996	15.8%	2
1997	19.1%	2
1998	23.6%	1
1999	23.6%	2

* Only includes whales that were assigned identification numbers.

Seasonal Distribution: We observed whales throughout Glacier Bay and Icy Strait, with the highest numbers concentrating around Bartlett Cove and Point Adolphus (Fig. 1). In June, the highest density of whales in Glacier Bay was around Flapjack Island, with slightly lower densities documented throughout July and August. For a 3-week period in late June and early July, the area around the Marble Islands was frequented regularly by an unusually high number of whales, with as many as 12 individuals identified on a single day. The majority of pods documented around the islands were very close to shore and consisted of 2 or more whales, with some pods containing up to 6 whales. Because of this high concentration of whales, a special 10 knot vessel speed limit was put into effect around the Marble Islands until whales dispersed away from the area in mid-July.

In July, whale use of Sitakaday Narrows and Bartlett Cove peaked, although whales were common in both of these areas throughout the summer. Overall, most of the whales in this area frequented the east side, but by mid-August activity had dropped off in Bartlett Cove, remained high along the shorelines of Lester and Young islands and increased in west Sitakaday Narrows. In August, whale numbers peaked in the Beardslee Entrance, along the edge of the Beardslee Islands and around Leland Island. Whales were documented in the middle of Glacier Bay throughout the summer with a peak in August (n = 5). Only one whale was documented in Whidbey Passage during the entire study period, but single whales were reported there on 3 occasions in June and August (J. de la Bruere, M. Goodro and L. Matlock, pers. comm.). On 21 July, a whale was reported in the back of Berg Bay, outside of our regular survey area (J. Bowen, pers. comm.). Whale #801 and her calf were documented 3 times in Beartrack Cove in July and August.

Despite bi-weekly surveys of the West Arm, we only documented 6 pods there during the study period. However, Park staff reported as many as 5 whales in the West Arm in late May (not shown in Fig. 1) between Russell Island and Hugh Miller Inlet (D. Lucchetti and L. Matlock, pers. comm.). In addition, from June to August, 1-2 whales were sighted occasionally between Composite Island and the entrance to Tidal Inlet (M. Goodro, J. de la Bruere, M. Blakeslee, K. Jones and E. Scott, pers. comm.) and a mother/calf pair was sighted on 3 occasions in Reid Inlet (J. Richards, pers. comm.). In late June and early July, we received reports of 1-2 whales in the upper East Arm just south of McBride Inlet (J. de la Bruere, R. Price and N. Buck, pers. comm.).

In Icy Strait, high numbers of whales were observed close to shore around Point Adolphus and Pinta Cove in June and August, with a sharp decline in mid-July. On 8 July, activity appeared to have shifted offshore as numerous whales were documented feeding in the middle of Icy Strait simultaneous with a decline in whale numbers closer to shore at Point Adolphus (N. Koehler, pers. comm.). On 13 July, we surveyed the mouth of Idaho Inlet after receiving a report of a high concentration of whales there a few days earlier (T. Morrow, pers. comm.). We identified 16 whales, many of them individuals usually seen off Point Adolphus and Pinta Cove, and sighted many more that we did not approach for photo identification. Observers at Point Adolphus reported that very few whales used that area between 9 July and 15 July, with a noticeable increase in whale activity on 18 July (N. Koehler, pers. comm.). On our 29 July Icy Strait survey, we observed that the temporary westward shift in whale distribution away from Point Adolphus and Pinta Cove had ended and whales were regularly sighted again in these areas in high concentrations.

Whale use near Mud Bay peaked on 24 June at 13 whales (8 of which comprised the core group), with very few whales sighted there later in the summer. There were occasional sightings off Lemesurier Island throughout the study period. No whales were documented around Pleasant Island or off Gustavus Flats, however these areas were surveyed infrequently due to time and weather constraints.

Local Movement and Residency: Twenty-two of the 104 total whales, including 1 mother/calf pair, were sighted in both Glacier Bay and Icy Strait between June 1 and August 31. Thirty-eight, including 5 mother/calf pairs, were sighted exclusively in Glacier Bay and 44, including 3 mother/calf pairs, were sighted exclusively in Icy Strait. Nine individuals, made one or more round trips between areas (Appendix 1). In August, female #281 was sighted in the study area for the first time since 1985, although she was documented as recently as 1995 in Frederick Sound (J. Straley, unpublished data.)

Twenty-eight (47%) of the 60 whales, including 4 mother/calf pairs, that entered Glacier Bay between June 1 and August 31 remained 20 or more days, long enough to be considered resident (after Baker et al. 1983). Twenty-six (39%) of the 66 whales, including 2 mother/calf pairs, in Icy Strait were considered resident in that area during the study. Sixty-one (59%) of the 104 whales in Glacier Bay/Icy Strait were resident in the combined Glacier Bay/Icy Strait area.

Twenty-five (24%) of the whales that entered the study area between June 1 and August 31 were identified on just one day: 10 in Glacier Bay and 15 in Icy Strait. In addition, 4 whales, including 1 mother/calf pair, that entered the area outside of the study period (*i.e.*, in May and September) were identified on just one day, all in Glacier Bay. All of these individuals were sighted in areas that are historically part of our regular survey areas (most notably Point Adolphus (n = 6), Sitakaday Narrows (n = 5) and Pinta Cove (n = 4)) with the exception of the entrance to Idaho Inlet (n = 3), where surveys are irregular. The sightings of whales that were seen on just one day are spread temporally throughout the season and do not appear to represent a pulse of whales arriving together in the study area (Appendix 1).

Reproduction and Juvenile Survival: We documented a total of 10 mother/calf pairs in the study area in 1999. However, one of these pairs (#525 and her calf) was seen only in May, outside of the normal survey period. All of the mother/calf pairs except #600 and her calf were sighted in either Glacier Bay or Icy Strait, but not in both areas (Table 5). Furthermore, half of the mother/calf pairs that were sighted more than once during the study period seemed to use relatively specific areas within either Glacier Bay or Icy Strait. For example, all (n = 10) of the sightings of mother #236 and her calf were in the lower part of Glacier Bay (between Bartlett Cove, Ripple Cove, and Strawberry Island); all (n = 2) of the sightings of mother #1246 and her calf were in Bartlett Cove; 88% (n = 7) of the sightings of mother #219 and her calf were at Point Adolphus in Icy Strait; and 80% (n = 4) of the sightings of mother #1018 and her calf were in the West Arm of Glacier Bay. Interestingly, half of the sightings of mother #801 and her calf were in Beartrack Cove, while the other half of the sightings (on interspersed days) were approximately 28 km to the northwest at the entrance to the West Arm.

We obtained fluke identification photographs of 7 of the mothers and 5 of the calves. We obtained high quality dorsal fin photographs of the remaining mothers and calves. The sex of two of the mothers (#1246 and #525) was not known previously. We saw #1246 with her calf on July 6 and July 12 in Bartlett Cove, but we documented #1246 alone during a 24 minute encounter on August 24 at the back of Bartlett Cove, although we did not recognize her as a mother without her calf. We saw no evidence of any other whales in the area, although intermittent rain made observation conditions less than ideal. The crude birth rate of the study population for 1999, computed by dividing the number of calves by the total number of whales, was 8.7% (Table 6).

Table 5. Females Identified with a Calf in Glacier Bay and Icy Strait 1999.

Mother ID#	Calf ID#	# of days sighted in Glacier Bay	# of days sighted in Icy Strait
1. 219	1485	0	8
2. 236	1487	10	0
3. 541	1488	0	2
4. 600	-	1	1
5. 801	-	6	0
6. 1018	1484	5	0
7. 1246	-	2	0
8. DFO_mom_GB99-8	-	2	0
9. DFO_mom_GB99-59	-	0	1
10. 525*	1483*	2	0

Note: Only calves whose flukes were photographed received an identification number.
* Indicates mother/calf pair documented in May only (outside of the June 1-August 31 study period.)

We identified four whales that had not been sighted in the study area since they were calves: whale #1439 (age 1), whale #1421 (age 2), whale #1313 (age 5) and whale #1052 (age 9). The 1974-1999 the average age of returning offspring (n = 31) to the study area was 3.2 years old (s.d. = 2.2). We photographed 23 of the 31 known-age whales in the population in 1999, comprising 21% of the total 1999 population. In comparison, between 1982 and 1998, 3-19% of the total annual population count was comprised of known-age whales. Twelve of the known-age whales in the study area in 1999 were born to just 4 females (#236, #530, #581, #801). All of these prolific females (except #530, who has not been identified in southeastern Alaska since 1994) were sighted in 1999 and 2 of them (#236 and #801) were accompanied by new calves.

Table 6. Crude birth rate of humpback whales in Glacier Bay and Icy Strait, June – August 1985-1999.

Year	#Whales	#Calves	Crude Birth Rate (%)	#Calves Photographically Identified
1985	41	2	4.9	1
1986	49	8	16.3	5
1987	60	4	6.7	3
1988	53	8	15.1	5
1989	41	5	12.2	3
1990	49	6	12.2	6
1991	53	4	7.5	4
1992	65	12	18.5	11
1993	50	3	6.0	3
1994	60	9	15.0	5
1995	57	3	5.3	3
1996	77	7	9.1	2
1997	82	9	11.0	7
1998	92	8	8.7	7
1999	104	9	8.7	4

Note: #Whales = total number of Glacier Bay and Icy Strait whales (including adults and calves), #Calves = number of calves, CBR % = crude birth rate, a percentage computed by #Calves / #Whales.

Habitat Characteristics: We measured sea surface temperature during 300 whale observation sessions in June, July and August 1999. The average sea surface temperature was 9.3 ^{o}C (s.d. = 1.37, range = 7-14.2, Fig. 2). We compared this year's measurements with June, July and August measurements from 1998 and previous years (Fig. 2) and found statistically significant differences among years (Kruskal Wallis H = 20.9, df = 2, p = 0.0001). Pairwise tests revealed that sea surface temperatures in 1998 were signficantly higher than in 1999 (Mann Whitney U = 30872, p = 0.0001) and previous years (Mann Whitney U = 47795, p = 0.0002).

We measured water depth during 301 whale observations in June, July and August 1999. The majority of whales (56%) were in water 60 m or less in depth. Whales were found in a wide range of water depths ranging from 5 to 405 m (Fig. 3). We compared these data with previous years data, segmented into the same year categories as the Fig. 2 temperature data for ease of comparison (Fig. 3).

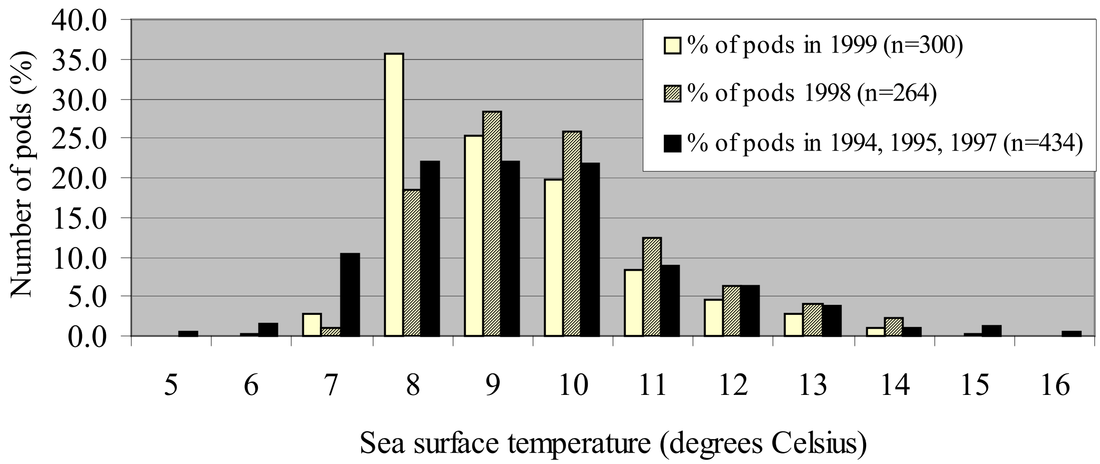


Figure 2 . Sea surface temperature near humpback whale groups in 1999 vs. previous years (1994, 1995, 1997). Data for 1996 are not available.

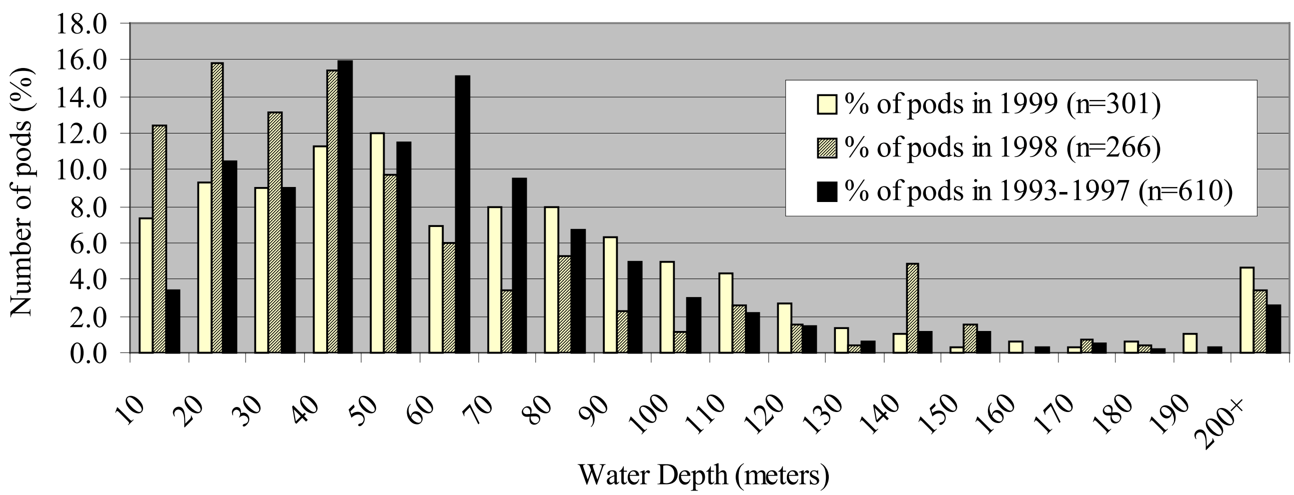
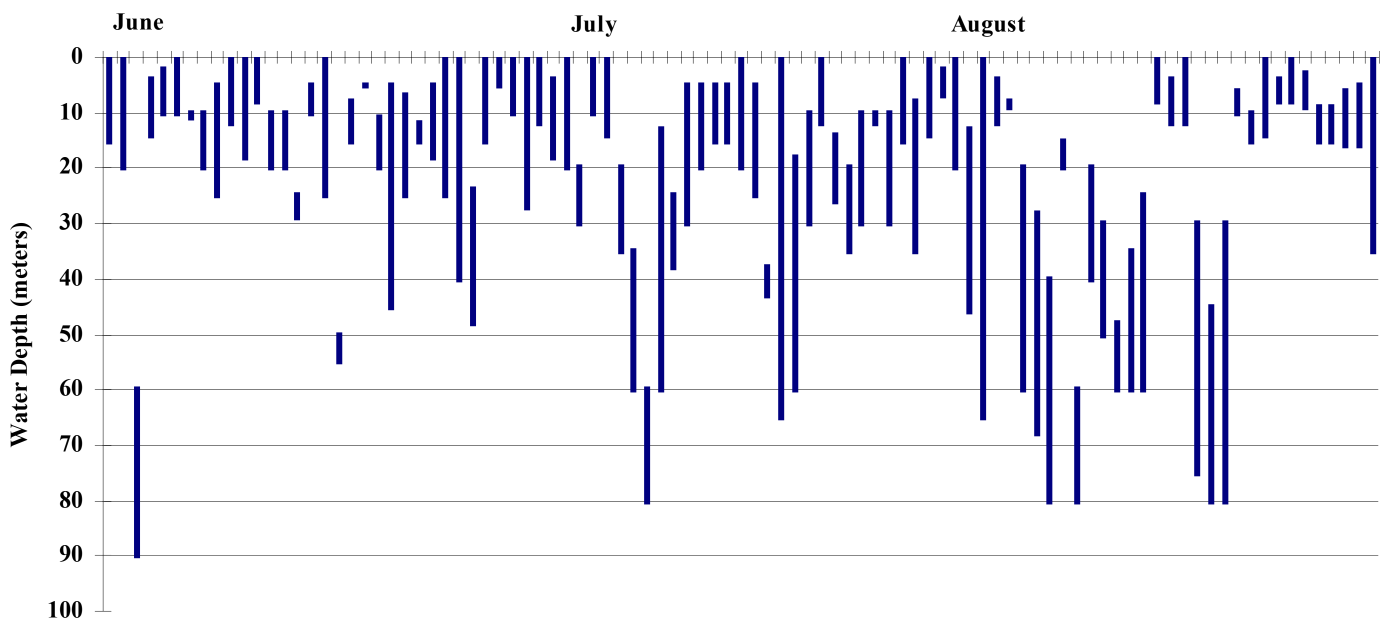


Figure 3. Water depth near humpback whale groups in June, July and August 1999 vs. 1998 and 1993-1997. Water depths were rounded to the nearest 10 meters (e.g. 20 meters on axis represents 16-25 meters, 30 meters represents 26-35 meters).

Prey Assessment: We made 105 qualitative observations of echo-sounder traces although we could not determine whether whales were feeding on the potential prey patches that we observed. The upper edge of potential prey patches we observed near whales ranged from 0-60 m (Fig. 4). In 87 cases (82%) the upper edge of the prey patch was within 20 m of the surface, and in 33 of all cases (31%) it was at or near the surface. Fifty-four percent (n = 57) of the lower edges of prey patches were also within 20 m of the surface (range 5-90). The upper edge of prey patches appeared more likely to be deeper in August as compared with earlier in the season (Fig. 4).

Figure 4. Vertical Extent of Prey Patches near 106 humpback whale groups: 1999



The predominant prey patch shape we observed was ‘patch’ (n = 55, 52%). Other prey patch types were ‘scattered’ (n = 18, 20%), and ‘layer’ (n = 10, 11%). In 74 observations of humpback whale groups we specifically noted that we saw nothing on the echo-sounder screen. During 3 of these cases we observed the whales vertical or lateral lunge feeding but in the remaining cases we saw no visible feeding behavior.

We determined the potential whale prey type on 3 occasions. On August 19, we observed dense balls of schooling fish near the water's surface in outer Bartlett Cove. We collected a sample of these fish with a dip net in close proximity to a feeding whale (#118) and later identified the fish as capelin. On 24 June, we observed dense balls of herring off Point Adolphus near several whales. The herring were schooling under dense patches of zooplankton and small fish near the water's surface. We collected a sample containing everything except the herring with a dip net, and later identified the zooplankton using a microscope. The most abundant zooplankton in the sample were calanoid copepods, followed by euphausiids and crab larvae. In addition, there were numerous mysids, hyperiid amphipods, arrow worms, and miscellaneous unidentified larval and juvenile fish. We were unable to determine whether or not the whales nearby were feeding on any or all of these potential prey items.

On 6 August, we collected a scat sample from whale #1484 (the 1999 calf of whale #1018) with a dip net when it defecated during an encounter at the entrance to the West Arm of Glacier Bay. The rust-colored scat was floating at the water's surface in numerous 6-14 inch long tubular masses, each of which were 2-2.5 inches in diameter. A professional laboratory analysis of the prey remnants in the scat revealed that the calf had been feeding on solid food items including fish and invertebrates (S. Crockford, pers. comm.). The fish bones recovered were most likely from juvenile walleye pollock and Pacific herring, although there is a slight possibility that they were from Pacific cod (*Gadus macrocephalus*) and American shad (*Alosa sapidissima*) and/or sardine (*Sardinops sagax*) (S. Crockford, pers. comm.). The most numerous invertebrate remains were antennae or other appendage from an invertebrate that does not appear to be a euphausiid (B. Wing, pers. comm.). The sample also contained a single fragment that may have been from the carapace of a Crangonid shrimp (B. Wing, pers. comm.). We will attempt to confirm the latter two identifications with further analysis of the invertebrate remains.

Feeding Behavior: We documented the feeding behavior of 149 different groups of whales in 1999. We categorized most of the feeding behavior we observed (n = 132) as subsurface feeding. We observed vertical or lateral lunge-feeding on several occasions (n = 28). We observed 3 instances when a whale produced bubbles during feeding, but no incidences of bubblenet feeding. We observed flick feeding on one occasion. We received one anecdotal report of group bubblenet feeding at Point Adolphus on July 17 (N. Matsumoto, pers. comm.). In addition to the 142 encounters in which we thought the whales were feeding, there were 68 other cases in which we suspected that the whale was travelling or resting and not feeding, and 90 observations we could not determine whether or not the whale was feeding. Except when whales were feeding at the surface, it was impossible to verify our assumptions of whether or not the whales were feeding.

We observed the 'core group' (after Perry et al. 1985; Gabriele 1997) on 9 occasions between June 4 and August 19. The core group seemed unusually large in 1999, with group sizes of 7 to 15 whales (6 of these observations contained 10 or more whales). Between 1985 and 1998, there were no observations of the core group containing more than 9 whales. Most core group sightings occurred in the vicinity of Point Adolphus, although a June 24 sighting occurred nearer to the daymarker near Mud Bay. Although we did not survey the Point Adolphus area between July 8 and July 29, other observers (N. Koehler, pers. comm.) told us that the core group was not in the Point Adolphus vicinity between July 9 and July 17. We identified several typical core group members (#587, #577, #539 and #186) amongst a loose aggregation of over 20 whales at the mouth of Idaho Inlet on July 13. One of these encounters was notable because the pod contained female #587 and #1298 her 7 year old offspring, (along with #577, #350 and #937).

Twenty-seven different individuals were sighted with the core group this summer, although the 12 whales that were seen in the group 3 or more times in 1999 have all been sighted with the core group in previous years (#587, #573, #186, #166, #577, #155, #1061, #221, #353, #933, #1345, #875). Males #577 and #166 were in the group on 7 occasions in 1999 but had not been sighted with the core group since1996 although they were in the study area. Female #236 and her calf were identified frequently in lower Glacier Bay in 1999, but this is the third consecutive year of her absence from the core group. Another unique factor in our 1999 observations of the core group was the predominance of in-air vocalizations. In most previous observations, the group would surface with no airborne sounds aside from respiration. This year, one or more whales frequently produced a "trumpet blow" several times during their surfacing(s). Over a 3 day period (August 20-22), we observed that the group produced these vocalizations on nearly every surfacing, day or night, regardless of whether any vessels were in the vicinity. There appeared to be at least three distinct "voices" belonging to different whales. On one occasion we determined that the trumpet-blowing whale was #587.

Whale/Human Interactions: Due to the high concentration of whales around Point Adolphus, whale watching by kayakers, private and charter vessels, cruise ships and people onshore is common. We observed 2 interactions between whale watchers and whales at Point Adolphus that are worthy of note. On 20 August, we observed the cruise ship *Veendam* approaching within 400 m of the shore and within 100 m of several whales, including one that dove not far off the ship's bow. Observers at Point Adolphus reported that this was not a unique occurrence; they observed this ship repeatedly throughout the summer maneuvering very close to shore and whales (B. Christensen, pers. comm.). We contacted a representative from Holland America cruise lines who was very concerned about these observations and assured us that they would be investigated.

On July 29 we observed a private vessel, approximately 5.5 m in length, maneuvering near the core group at Point Adolphus. Once the vessel was close to the whales, they dropped 2 kayaks in the water (a single and a double) and the kayakers proceeded to paddle near the whales, taking photographs. This was the first time that we had observed a vessel dropping off kayakers in order to whale watch.

Two more noteworthy whale/vessel interactions occurred near the Glacier Bay/Icy Strait study area. On July 26 the cruise ship *Westerdam* struck and apparently killed a humpback whale in Stephens Passage, approximately 100 km south of Juneau. According to a report in the Juneau Empire (Fry 1999), the ship was transiting at about 19 knots when it collided with the 10-12 m whale. The crew was unaware of the whale's presence in the area prior to the collision and noted that the person at the helm has a blind spot of approximately 73 m in front of the bow at the waterline. As the ship slowed down, the whale slipped off the bulbous part of the bow and sank, precluding possible identification of the individual based on markings on its flukes or dorsal fin. A cruise line representative speculated about whether or not the whale was alive prior to the collision.

On September 6, a humpback whale surfaced underneath a 9 m fiberglass sailboat that was underway near Hoonah, approximately 40 km southeast of Glacier Bay. The whale slapped its tail on the forward deck, causing damage that resulted in the boat taking on significant quantities of water (K. Brix and J. Straley, pers. comm.).

There were no whale strandings, entanglements in fishing gear, or disturbances by aircraft reported in the Glacier Bay/Icy Strait area. However, we documented that 5 whales (male #159, male #577, probable male #584, whale #1061 and whale #1304) in the study population had large peduncle scars and/or deformations that had not been noted in past years. Whether or not these injuries were anthropogenic is unknown. However, whale #584's deformed peduncle was so distorted that it is difficult to imagine that it resulted from anything other than a collision with a large vessel.

DISCUSSION

Vessel Surveys: Survey effort, as indicated by the total number of surveys and hours, was slightly lower in Glacier Bay in 1999 than in 1997 and 1998 but somewhat higher than the number of surveys and hours in 1985-1996. The temporal distribution and average duration of each survey in Glacier Bay have remained nearly constant throughout the history of the study. However, in Icy Strait, survey effort, as well as the average duration of each survey, were low for the second year in a row. It would be advisable to increase the number of surveys and the length of each survey in Icy Strait, and perhaps slightly decrease survey effort in Glacier Bay to maintain comparable levels of effort in each area for all years of the study.

Whale Counts: The 1999 total count of 104 whales represents the highest number of whales ever identified in the study area in a single season (Table 3). In Icy Strait, the total count of 66 whales was the highest ever recorded, while the standardized count was the second highest ever recorded. In Glacier Bay, the total and standardized counts were slightly below the record numbers documented in 1997 and 1998, but above average for all years. Glacier Bay and Icy Strait appeared to contribute equally to the high annual whale count, with 38 whales sighted only in Glacier Bay, 44 whales sighted only in Icy Strait and 22 whales sighted in both areas. Although survey effort in Icy Strait was relatively low compared with past years, we identified a record number of whales in this area. It is worth noting that whale counts in Icy Strait would probably have been even higher with additional survey effort. Three of the whales that were sighted only once (#1461, #1481 and #539) were at the mouth of Idaho Inlet, an area not consistently surveyed every year. Overall, the 1999 data definitively support the continued increasing trend in Glacier Bay, Icy Strait and in the combined Glacier Bay/Icy Strait area.

In 1998 we evaluated the potential effects of inter-observer differences, varying levels of effort, and increasing use of dorsal fin photographs on whale counts and concluded that none of these factors were likely to be responsible for the magnitude of the observed increase in whale numbers (Gabriele and Doherty 1998). In

1999, to rule out the possibility that an increased use of dorsal fin identification photographs might be inflating whale counts in recent years, we quantitatively re-examined whether or not there had been an increase in the use of such photographs to identify whales from 1994 to 1999 (Table 4). We found that the use of dorsal fin identification photographs remained relatively constant during this time period and therefore cannot be responsible for the increasing trend in whale numbers. Although dorsal fin identifications don't tend to add new whales to the counts, they do augment individual whales' sighting histories (see Local Movement and Residency). Our results continue to support the conclusion that the observed increasing trends reflect a real increase in whale abundance in the study area (Gabriele and Doherty 1998) likely related to an increasing trend in the size of the North Pacific humpback whale population (Calambokidis et al. 1997).

Seasonal Distribution: Overall, whale distribution in Glacier Bay was similar to that observed in previous summers with the greatest activity concentrated in the lower parts of the bay. As in the past, Bartlett Cove and Sitakaday Narrows continue to be important habitat for whales throughout the season. Forty-seven different whales were identified between the entrance to Glacier Bay and north Strawberry Island over the course of the season, with a maximum of 16 different individuals identified on a single day in mid-July. Whale use of the waters surrounding Flapjack Island peaked earlier in the summer than in previous years. Beartrack Cove, an area where we do not often find whales, was used regularly by #801 and her calf in July and August. Whale distribution around the Marble Islands and in the middle of Glacier Bay was atypically high compared with previous years. The high concentration of whales observed in late May and early June 1998 between Adams Inlet and Sandy Cove were not observed in 1999, however, survey effort in this area was low early in the 1999 season. Whale numbers in Whidbey Passage and the West Arm were even lower than in 1998, when a reduction in the number of whales in these areas relative to previous years was noted (Gabriele and Doherty 1998.) Continued monitoring of the distribution of whales throughout the study area is needed to identify what areas are important habitat for whales and to determine whether shifts in distribution (*e.g.*, the heavy use of the area around the Marble Islands or the light of use of the West Arm) are short-term or whether they may warrant changes in the Park's vessel management policies pertaining to whale waters.

In Icy Strait, whales were distributed comparably to past summers with the majority of whales concentrated around Point Adolphus. However, the apparent temporary westward shift in July of large numbers of whales from Point Adolphus to the mouth of Idaho Inlet had not been as pronounced in previous years. It would have been helpful to have conducted more surveys around Point Adolphus in July to quantify this shift, but weather conditions prevented us from completing surveys in Icy Strait during this time period. Whale distribution in eastern Icy Strait, particularly around Pleasant Island and Gustavus Flats, should not be compared with past years' data because of the minimal survey effort in this region in 1999.

Local Movement and Residency: Overall patterns of whale movement in 1999 were similar to previous years. The percentage of whales documented making round trips between Glacier Bay and Icy Strait (9%) was slightly lower than the percentage documented between 1994 and 1998 (11-14%). The proportion of 20-day 'resident' whales in Glacier Bay, Icy Strait, and the combined Glacier Bay/Icy Strait area was comparable to the proportions documented in previous years. The proportion of whales sighted on just one day during the study period in 1999 (24%) was similar to the proportion in 1998 (23%), but low compared with the proportions documented between 1994 and 1997 (30-43%). The apparent decline in the likelihood of whales being sighted on just one day could be attributable to the increasing use of dorsal fin photographs, or other factors. However the fact that the proportion was low in 1998 and 1999 (when whale numbers reached record levels) relative to past years indicates that these "one day" whales are probably not responsible for the current increasing trend in whale numbers.

Reproduction and Juvenile Survival: The fact that over half of the known-age whales that returned to the study area in 1999 were born to just 4 females also illustrates direct link between the local population's recruitment rate and the fate of each of these prolific females. The observation that all but one of the mother/calf pairs in 1999 were specific to either Glacier Bay or Icy Strait (a pattern also observed in 1998), highlights how crucial each area is to the reproductive success of a particular female. In addition, many mother/calf pairs and other whales appear to rely on even smaller areas throughout the summer, making them especially vulnerable to negative impacts to their preferred habitat (*e.g.*, an oil spill). We can only speculate as to why #801 and her calf seemed to have a preference for two discrete areas (Beartrack Cove and the entrance to the West Arm), but perhaps these two areas are have prey species available and/or abiotic features in common.

The crude birth rate of the study population in 1999 (8.7%) was comparable to the average rate of 10.6% (s.d. = 4.4%) between 1985 and 1998. The discovery that #1246 and #525 are females is an important piece of information in understanding the demographics of whales in the study population. It will be interesting to see if #1246's calf (identified by dorsal fin only) is resighted in future years after its possible disappearance in August. We have frequently observed calves away from their mothers, sometimes for extended periods of time (Gabriele and Doherty 1998; Gabriele et al. in prep.) but in this case the calf must have been outside of Bartlett Cove because we did not see any other whales in the cove. The identification of 4 whales in 1999 that had not been sighted since they were calves highlights the value of long-term studies in understanding site fidelity and habitat use by returning offspring. The proportion of the population comprised of known-age whales (21%) increased over previous years (3-19%). As our catalog of photographically identified calves grows, we can expect this proportion to continue to increase because each year we have the opportunity to document more of these calves returning to the study area for the first time.

Habitat Characteristics: The temperature distribution we observed was consistent with the El Nino Southern Oscillation (ENSO) ocean warming in 1998 and cooling in 1999 that has been documented in other areas (Suplee 1999). Our results should be interpreted cautiously because of the imprecision of the temperature sensor we used. The positive 1.3 degree bias of the temperature sensor would tend to underestimate the relatively cool sea surface temperatures we recorded in 1999. However, the graphic results (Fig 2.) show differences in the distributions of sea surface temperatures greater than the 1.3 degree resolution of our temperature sensor.

The water depth data are collected primarily for descriptive purposes, but it is interesting to make qualitative comparisons among years. In general, the 1999 whales were spread over a wide range of depths with no emphasis on a particular depth. In 1999, 56% of the whales we observed were in water shallower than 60 m, as compared with approximately 70% of whales in 1997 and 1998.

Prey Assessment: Our descriptions of the vertical extent of prey patches (Fig. 4) are primarily for descriptive purposes, but might provide insight into the distribution and abundance of species that feed on the same suite of prey items as humpback whales. For instance, the distance of prey patches from the surface could determine their availability to surface feeders such as gulls and to a lesser extent, diving birds. Unfortunately, without information on the species composition of these echosounder traces, it is difficult to interpret the factors influencing the vertical extent of potential prey patches (Fig. 4). However, we believe that continuing to document these attributes could increase our understanding of whale interactions with their prey.

Humpback whales were numerous in the study area, in the fourth consecutive year in a series of markedly higher whale counts (Table 3). However, there are indications of decreasing numbers of harbor seals (Mathews and Pendelton 1999), harbor porpoises (Gabriele and Lewis, in prep.) and murrelets (J. Piatt pers. comm.) in the study area, as well as anecdotal observations of fewer seabirds in 1999. More information provided by the U.S. Geological Survey's Biological Resources Division studies of forage fish (*e.g*., Robards et al. 1999) may elucidate the potential role of food availability in the contrasting abundance trends of humpback whales and other species.

The identification of capelin outside Bartlett Cove and herring off Point Adolphus as potential prey species is consistent with previous studies that documented these species near feeding humpbacks (Krieger and Wing 1984, 1986; Gabriele 1996; Gabriele et al. 1997; Gabriele and Doherty 1998). We do not know if the whales at Point Adolphus were feeding on the dense aggregations of zooplankton that we sampled, but it is interesting to note that euphausiids, a primary humpback whale prey species in other areas (Krieger and Wing 1984, 1986; Kieckhefer 1992), were abundant in the sample.

The results of the analysis of calf #1484's scat were particularly valuable because they tentatively confirm that walleye pollock and Pacific herring are preyed on by whales in the study area, as indicated circumstantially by samples collected in the past near feeding whales in Glacier Bay and Icy Strait (Gabriele 1996; Gabriele and Doherty 1998; Krieger and Wing 1984, 1986). Although the invertebrate remains in the scat are not yet identified, the only confirmed records of humpback whales feeding on euphausiids in Glacier Bay (n = 2) occurred in the same area where we collected the scat sample, at the entrance to the West Arm (Krieger and Wing 1986). The tentative identification of a Crangonid shrimp carapace was unexpected as we are unaware of any studies documenting them as humpback whale prey. However, these shrimp are known to be important prey for many species of fish (Jensen 1995), and it is possible that the shrimp was consumed by the whale while it was feeding on fish. We hope to definitively confirm the identity of the invertebrate remains and thereby enhance our understanding of the array of species consumed by whales in Glacier Bay.

Feeding Behavior: The predominance of subsurface feeding behavior in 1999 was typical of previous years. Lunge feeding seemed somewhat less common in 1999 with only 28 occurrences, as compared with 1998, when we observed it on 60 occasions (Gabriele and Doherty 1998). The lack of bubblenet feeding during the 1999 season was typical of most recent years, but stands in marked contrast to 1998 when we observed bubblenet feeding on 10 occasions.

The behavior and composition of the core group continues to be dynamic with an underlying kernel of continuity. We do not know whether a larger group size implies more abundant prey, or conversely, whether less abundant or more dispersed prey made it necessary for whales to hunt as a group in order to obtain sufficient food. Based on our observations, we speculate that airborne vocalizations indicate that whales are agitated. If this is the case, this could suggest that there was excitement over particularly good feeding, or squabbling within the group due to scarce resources. It is interesting to speculate about why the group was larger than usual this season, but without data on prey distribution and abundance, our ideas will remain speculative.

Although the main factor in the group's size was the intermittent presence of 27 non-typical group members, the group's size is attributable in part to the presence of most of the long-term typical core group members (Perry et al. 1985; Gabriele 1997). Previous observations suggested that some typical core group females do not participate in the group in years that they have a calf (Perry et al. 1985), giving us some basis to expect the absence of female #236 and her calf and the presence of females #587, #155, #573 and #353. However, it is not known why males #577 and #166 chose to feed with the core group this year, although they were absent from the group in 1997 and 1998. We speculate that whatever advantages whales gain by feeding as a group (Baker 1985) may be balanced by the costs of feeding in a heavily trafficked area where large groups tend to attract numerous whale watching vessels (Gabriele 1995). It would be interesting to compare the recruitment rates of the offspring of core group females with other females to determine whether the risks of vessel collision (Gabriele 1992) and the possible cumulative effects of disturbance (Baker and Herman 1989) have an effect on female reproductive success. Notably, the only two definite mid-summer calf mortalities documented in the study area involved core group mothers (Baker 1986; Baker and Straley 1988). Our finding that 12 of the known-age whales that returned to the study area in 1999 were born to just 4 females demonstrates how profound the contribution of a single female's reproductive success can be to the local population. It also implies that the effects of protecting or neglecting important feeding areas such as Point Adolphus may become apparent in population recruitment even over the short term.

Whale/Human Interactions: The risk of whale/vessel collisions involves all types of vessels, whether actively whale watching or in transit, and occurs not only at Point Adolphus but everywhere in southeastern Alaska where whales and boats coexist. However, cruise ships may be a particular concern because the larger the vessel the higher the likelihood that a collision would be fatal to the whale. Maneuvering a large ship very close to land in order to watch whales would also seem to generate an increased potential for a running aground and subsequently spilling oil at Point Adolphus. The observations of the cruise ship *Veendam* maneuvering in close proximity to whales and shore at Point Adolphus are particularly worrisome in light of the fact that the helmsman of a cruise ship such as the *Westerdam* has a blind spot of approximately 73 m in front of the bow. It seems reasonable to suggest that large ships should avoid maneuvering so close to whales that one might surface within this blind spot, and that the NMFS guidelines for large ships could perhaps be modeled after the ¼ mile minimum approach distance in Glacier Bay.

We are encouraged by the willingness of Holland America to investigate the *Veendam*'s behavior and resolve the issue. GBNP actively supports the NMFS Marine Mammal Viewing Guidelines and the agency's efforts to implement whale watching regulations. The NPS acknowledges that the popularity of Glacier Bay National Park attracts a substantial amount of vessel traffic to the sensitive Point Adolphus area. The NPS must become more proactive in making it clear to all concessioners that reports of violations of NMFS guidelines or regulations will be reported to NMFS and potentially noted in their annual GBNP concessioner evaluations. In our communication with concessioners, we plan to include an information packet, including a copy of the National Marine Fisheries Service (NMFS) guidelines for marine mammal viewing, to help ensure that all vessel operators (including cruise ship pilots) understand how to operate in a responsible manner outside the Park, particularly at nearby Point Adolphus.

Although kayakers are often seen whale watching at Point Adolphus, this was the first time that we had observed a vessel dropping off kayakers near a pod of whales. We have anecdotally observed that whales react to the presence of kayaks (JLD, personal observation), but the majority of kayakers at Point Adolphus remain very close to shore (inshore of the kelp beds) and therefore only have the potential for disturbing whales that are also very close to shore. However, if kayakers are dropped off on the water in order to "paddle with the whales", the potential exists for a greater level of harassment because a) the kayakers have the potential for encountering *all* whales, not just those close to shore and b) the drop off boat is fast and maneuverable and is able to track the whales as they move through the area; therefore the chances that the kayakers will encounter whales after a drop off is much higher than the chances that they will them encounter them after paddling from the beach. Data on recreational use of the Point Adolphus area will help to determine whether this was an isolated incident or a common practice. Kayakers may be unaware that National Marine Fisheries Service (NMFS) guidelines (recommending that vessels remain at least 30 m from whales (NMFS 1998)) also apply to kayaks.

The incident involving the whale that struck a sailboat under power on is highly unusual. To the best of our knowledge, in other cases where a whale has surfaced under a vessel, the vessel's engines have been off, leading us to assume that if the whale can hear the vessel, it will usually avoid it. This case is even more unusual in that upon surfacing under the bow, the whale did not dive immediately, but instead slapped its tail on the deck. We can only speculate as to why the whale reacted in this way and hope that other whales don't adopt this behavior pattern.

Our observations of numerous whales with apparently new scarring and deformities in 1999 are interesting, but due to the lack of a standard protocol for documenting scarring since 1985, we cannot quantify if the rate of scarring and/or deformities is changing. While the origin of these injuries remains unknown, some of the scarring patterns observed in 1999 are consistent with patterns attributed to previous entanglements in a study by Mattila and Robbins (1998). The increasing local whale population and the array of incidents involving cruise ships, kayaks, and private vessels highlights the need for increased awareness of whale/human interactions in southeastern Alaska.

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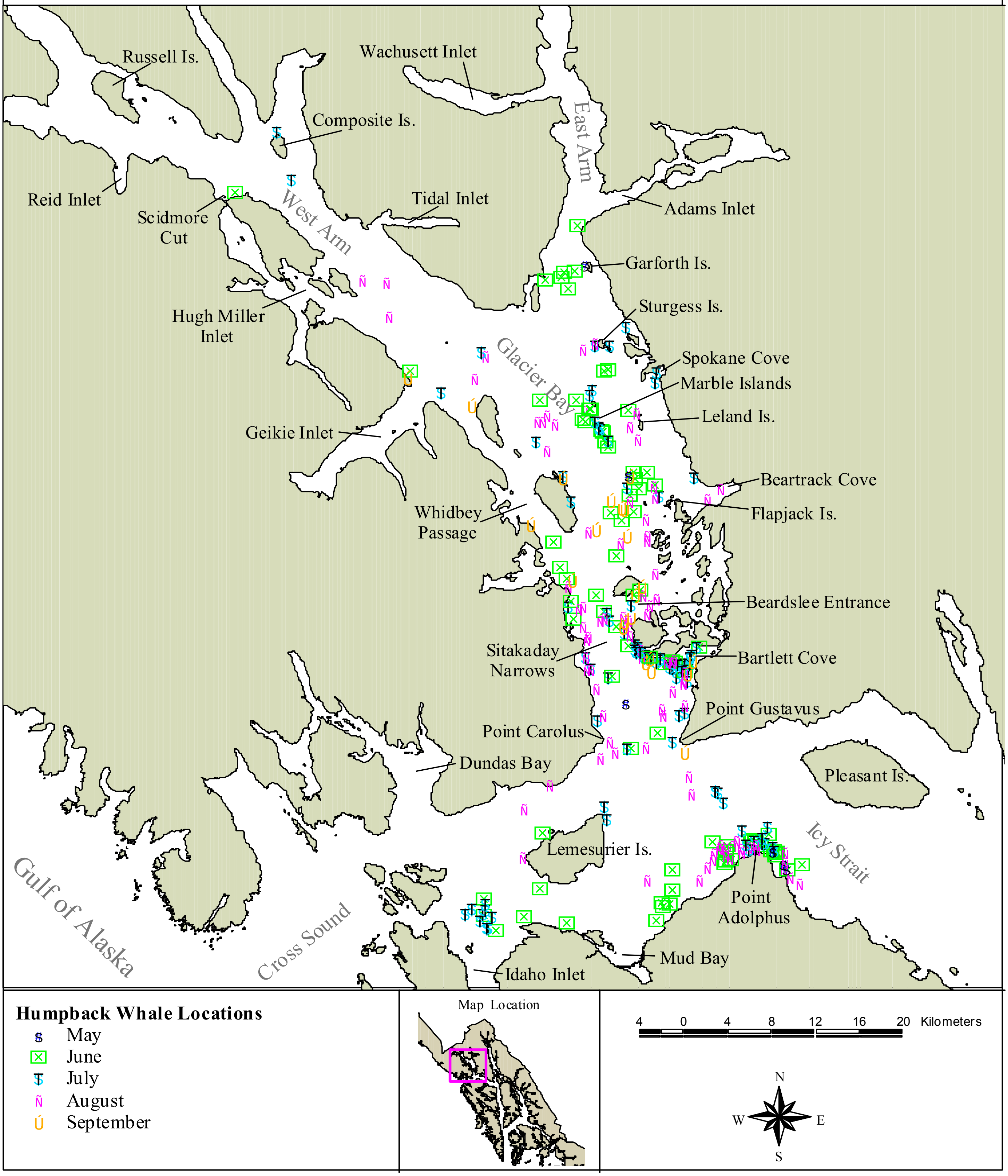
Figure 1. Humpback Whales in Glacier Bay and Icy Strait 1999



Appendix 1: 1999 Sighting Histories of Individually Identified Whales

	Whale ID#		5/14/99	5/17/99	5/19/99	6/1/99	6/2/99	6/4/99	6/7/99	6/8/99	6/9/99	6/10/99	6/11/99	6/17/99	6/18/99	6/22/99	6/23/99	6/24/99	6/25/99	6/29/99	7/1/99	7/2/99	7/3/99	7/6/99	7/7/99	7/8/99	7/12/99	7/13/99	7/14/99	7/16/99	7/19/99	7/20/99	7/21/99	7/22/99	7/23/99	7/26/99	7/29/99	7/30/99	8/2/99	8/4/99	8/6/99	8/9/99	8/11/99	8/12/99	8/17/99	8/18/99	8/19/99	8/20/99	8/23/99	8/24/99	8/25/99	8/26/99	8/30/99	8/31/99	9/1/99	9/7/1999	9/14/1999	9/27/1999	9/29/1999
1	525		G	G																																																							
2	1483	calf of 525	G	G																																																						
3	157	M.D.		I									I						G																		I					I					I						G	I	I				G
4	351			I		G											G				G			G			G		G		G	G	G							G			G			G	I									G			
5	577	Scoper		I				I					I															I									I					I					I							I	G				
6	587	Gertrude		I				I					I					I								I		I									I					I					I												
7	1431			I				I			I																															I																	
8	1292				G		G			G		G			G																																												
9	1293				G													I		G			G	G					G		G	G				G							G							G									
10	117	White Eyes				G						G			G						G						G						G							G			G																
11	196					G																																																					
12	250					G				G					G		G				G				G																																		
13	564	Roundup Taylor				G									G		G				G																																						
14	1018					G																G																	G		G			G															
15	1484	calf of 1018				G																G																	G		G																		
16	1052					G																																																					
17	1065					G	G																																G						G	G		G				G						G	
18	1079					G				G					G	G					G																										G				G	G							
19	1302					G						G			G																																	G				G							
20	535	Quits					G		G						G		G			G																																							
21	166	Frenchie						I					I													I											I					I					I												
22	186							I					I					I								I		I									I					I					I												
23	219							I					I					I								I											I					I					I							I				
24	1485	calf of 219						I					I					I								I											I					I					I							I				
25	221							I					I	G	G			I		G			G	G			G									G						I					I										G	G
26	573							I					I					I								I											I					I					I												
27	584							I					I																																		I												
28	875							I				G																									I					I										G							
29	933							I					I																								I					I																	
30	1042							I										I								I											I					I					I												
31	1046							I				G			G										G		G																								G								
32	1061							I					I															I									I					I																	
33	1083							I																G									I												G		G			G									
34	1244							I																G			G		G		G									G								G							G				G
35	1295							I					I		G																																											G	
36	1340							I																																																			
37	1425							I																																																			
38	801*								G																									G				G						G				G			G								
39	801_calf_1999	calf of 801							G																									G				G						G				G			G								
40	DFO_mom_GB99-8									G		G																																															
41	DFO_calf_GB99-8									G		G																																															
42	161	B.W.M.									I																	I								G																							
43	541										I																	I																															
44	1488	calf of 541									I																	I																															
45	895										I																																																
46	1031										I																																								G								
47	1432										I																													G															G				
48	1482										I																																				I												
49	159											G		G	G	G	G			G					G																		G	G				G											
50	235	Spot										G			G		G			G																																			G	G			
51	1304											G												G			G				G		G																	G								G	
52	118	Chop Suey											I											I		I							G				I					I					G							I					
53	193												I																													I																	
54	352												I					I															G														I			G									
55	516	Garfunkle											I													I																																	
56	581												I													I											I					I					I												
57	1453												I																																														
58	1421												I																																														
59	GB99-13(24)												I																																														
60	1014													G	G			I																G					G	G											G	G						G	
61	237	Dike													G							G																																					
62	937														G		G											I																															
63	1012														G		G				G										G							G					G							G		G							

Appendix 1: 1999 Sighting Histories of Individually Identified Whales

	Whale ID#		5/14/99	5/17/99	5/19/99	6/1/99	6/2/99	6/4/99	6/7/99	6/8/99	6/9/99	6/10/99	6/11/99	6/17/99	6/18/99	6/22/99	6/23/99	6/24/99	6/25/99	6/29/99
64	GB99-20(2A)																G			
65	154	Freckles																I		G
66	155	Freckle Fluke																I		
67	187																	I		
68	455																	I		
69	465																	I		
70	513																	I		
71	741																	I		
72	1372																	I		
73	1439																			G
74	1063																			
75	1299																			
76	1246																			
77	1246_calf_1999																			
78	1313																			
79	206																			
80	353																			
81	1345																			
82	225	Vagn																		
83	350	Lace																		
84	539	Max																		
85	600																			
86	600_calf_1999																			
87	1019																			
88	1298																			
89	1461																			
90	1481																			
91	616																			
92	1233																			
93	GB99-43(3)																			
94	1049																			
95	1473*																			
96	236	Leigh																		
97	1487	calf of 236																		
98	GB99-45(23A)																			
99	1489																			
100	1306																			
101	1478																			
102	318																			
103	397																			
104	DFO_mom_GB99-59																			
105	DFO_calf_GB99-59																			
106	281																			
107	250_calf_1996*																			
108	1011	Wide White Eyes																		

	Whale ID#	7/1/99	7/2/99	7/3/99	7/6/99	7/7/99	7/8/99	7/12/99	7/13/99	7/14/99	7/16/99	7/19/99	7/20/99	7/21/99	7/22/99	7/23/99	7/26/99	7/29/99	7/30/99
64	GB99-20(2A)																		
65	154																		
66	155						I											I	
67	187																		
68	455																		
69	465																		
70	513																		
71	741																		
72	1372																		
73	1439																		
74	1063	G		G		G		G		G									
75	1299			G												G			G
76	1246				G			G											
77	1246_calf_1999				G			G											
78	1313				G														
79	206						I												
80	353						I											I	
81	1345						I											I	
82	225							G											
83	350								I								G		
84	539								I										
85	600								I			G							
86	600_calf_1999								I			G							
87	1019								I										
88	1298								I										
89	1461								I										
90	1481								I										
91	616								G					I					
92	1233									G		G			G				
93	GB99-43(3)									G									
94	1049										G								
95	1473*										G								
96	236											G	G			G	G		
97	1487											G	G				G		
98	GB99-45(23A)													G					
99	1489															G			G
100	1306																	I	
101	1478																	I	
102	318																		
103	397																		
104	DFO_mom_GB99-59																		
105	DFO_calf_GB99-59																		
106	281																		
107	250_calf_1996*																		
108	1011																		

	Whale ID#	8/2/99	8/4/99	8/6/99	8/9/99	8/11/99	8/12/99	8/17/99	8/18/99	8/19/99	8/20/99	8/23/99	8/24/99	8/25/99	8/26/99	8/30/99	8/31/99	9/1/99	9/7/1999	9/14/1999	9/27/1999	9/29/1999
64	GB99-20(2A)																					
65	154																					
66	155				I					I												
67	187																					
68	455																					
69	465																					
70	513																					
71	741																					
72	1372																					
73	1439																					
74	1063																					
75	1299													G								
76	1246												G									
77	1246_calf_1999																					
78	1313																					
79	206																					
80	353				I					I												
81	1345				I																	
82	225																					
83	350																					
84	539																					
85	600																					
86	600_calf_1999																					
87	1019									I												
88	1298												G		G							
89	1461																					
90	1481																					
91	616																					
92	1233						G		G													
93	GB99-43(3)																					
94	1049																					
95	1473*										G			G								
96	236						G		G		G					G		G			G	
97	1487						G				G					G		G			G	
98	GB99-45(23A)																					
99	1489										G											
100	1306				I																	
101	1478																					
102	318				I																	
103	397				I					I							I					
104	DFO_mom_GB99-59				I																	
105	DFO_calf_GB99-59				I																	
106	281										G											
107	250_calf_1996*																	G				
108	1011																			G		